CLAIMS

What is claimed is:

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1. A method for forming a piezoelectric electrical current generating device having piezoelectric material plates joined to a substrate surface, the method comprising:

creating an initial sub-assembly by:

micromachining a plurality of masses supported by the piezoelectric material plates, the masses separated by a plurality of non-machined areas;

electrically bonding the non-machined areas to a flexible conductive sheath; and

cutting through the piezoelectric material plates in multiple locations to vibration tune each mass;

constructing a mirror-image copy of the initial sub-assembly; and

connecting the mirror image copy to the initial sub-assembly.

2. The method of Claim 1, comprising forming a plurality of individual piezoelectric material beams.

3. The method of Claim 1, comprising joining the piezoelectric material plates in a plurality of pairs to the upper surface of the substrate.

4. The method of claim 3, comprising:

trenching the upper surface of the substrate using photolithography and etching; and

filling the trenches of the upper surface with a sacrificial material.

5. The method of claim 4, comprising depositing a metallization film over the upper surface of the substrate and the sacrificial material.

6. The method of claim 5, comprising trenching the substrate using photolithography and etching.

7. A method for forming a horizontally configured piezoelectric electrical current generating device having a substrate including both an upper and a lower surface and a flexible sheath having electrical traces, the method comprising:

creating an initial sub-assembly by:

joining paired piezoelectric material plates to the upper surface of the substrate;

micromachining the lower surface of the substrate to both form a plurality of masses supported by said piezoelectric material plates and retain a plurality of non-machined lower surface areas;

electrically bonding the plurality of non-machined lower surface areas to the flexible sheath; and

cutting through the piezoelectric material to separate a plurality of individual cantilevered piezoelectric material beam lengths;

constructing a mirror-image sub-assembly of the initial sub-assembly; and

connecting the mirror image sub-assembly to the initial sub-assembly.

8. The method of claim 7, comprising:

aligning each of the plurality of individual cantilevered piezoelectric material beam lengths of the mirror image sub-assembly with selected ones of the plurality of individual cantilevered piezoelectric material beam lengths of the initial sub-assembly; and

connecting each aligned plurality of individual cantilevered piezoelectric material beam lengths to operably form a plurality of bimorph beams.

9. The method of claim 8, comprising:

forming a pattern of trenches using photolithography and etching on the upper surface of the substrate prior to joining the paired piezoelectric material plates; and

filling the trenches with a sacrificial material.

10. The method of claim 9, comprising depositing a metallization film over the upper surface of the substrate and the sacrificial material after filling the trenches with the sacrificial material and prior to joining the paired piezoelectric material plates.

11. The method of claim 10, comprising removing a pattern of trenches using photolithography and etching from a lower surface of the substrate after joining the paired piezoelectric material plates.

12. The method of claim 11, comprising etching to remove a remaining portion of the sacrificial material after cutting through the piezoelectric material.

13. A method for forming a vertically configured piezoelectric electrical current generating device which comprises the steps of:

filling until dry a mold with a ceramic piezoelectric slurry to operably form a piezoceramic green body;

bonding a piezoceramic wafer to the piezoceramic green body;

heat curing the piezoceramic wafer and piezoceramic green body to both remove the plastic mold and expose a plurality of piezoceramic vertical beams;

casting a resist over the beams along a top surface;

performing an X-ray exposure to operably create a plurality of recesses for an electrode structure; and

spin-coating a metal filled, negative X-ray resist on the top surface to operably create a plurality of cantilevered masses.

14. The method of Claim 13, comprising flood exposing a remaining portion of the vertical beams.

15. The method of Claim 14, comprising stripping both a remaining portion of the negative resist and the flood exposed resist.

16. The method of claim 15, comprising fabricating a mold insert to prepare the mold.

17. The method of claim 16, comprising performing a lithographie galvanic abformung (LIGA) machining process to fabricate the mold insert.

18. The method of claim 16, comprising fabricating the mold insert from a nickel material.

19. The method of claim 13, comprising:

polishing an exposed surface of the dried piezoceramic green body prior to bonding the wafer to the piezoceramic green body; and

depositing a metal conductive layer on the polished surface to form a plurality of electrical contacts of the piezoceramic vertical beams.

20. The method of claim 19, comprising nickel plating the recesses prior to flood exposure.

21. The method of claim 13, comprising planarizing the top surface.

22. The method of claim 13, comprising developing the remaining portion of the negative resist and the flood exposed resist.

23. A method to generate electrical current using a plurality of weighted masses formed in a multiple layer piezoceramic material, comprising:

separating the piezoceramic material into a plurality of masses connectably joined to a plurality of mass supports;

electrically bonding the mass supports to a conformable, conductive sheath;

removing material from the masses to operably limit a mass vibration deflection;

attaching the conductive sheath to a vibrating body; and

withdrawing an electrical current from the conductive sheath operably generated by vibration of the masses induced by the vibrating body.

24. The method of Claim 23, comprising conforming the conductive sheath to a surface contour of the vibrating body.

25. The method of Claim 24, comprising flexing the conductive sheath to conform the conductive sheath to the surface contour of the vibrating body.

26. The method of Claim 23, comprising pre-tuning the masses to match at least one natural frequency mode of the vibrating body.

27. The method of Claim 26, comprising pre-tuning the masses by at least one of:

varying a volume of the masses;

changing a height of the masses; and

controlling a spacing between the masses.

28. The method of Claim 23, comprising varying a quantity of the masses to operably vary the electrical current withdrawn.

29. The method of Claim 23, comprising applying a conductive adhesive to attach the mass supports to the conductive sheath.

30. The method of Claim 23, comprising:

creating two layers each having multiple ones of the masses and the mass supports; and

joining the two layers.

31. The method of Claim 23, comprising:

joining one of the masses and one of the mass supports to operably form an element;

electrically joining a plurality of the elements to operably form a cell unit; and

connecting a plurality of the cell units to operably form an array.

32. The method of Claim 31, comprising varying the electrical current by at least one of:

changing a quantity of the elements per cell unit; and

adjusting the plurality of the cell units per array.

33. The method of Claim 23, comprising generating the electrical current over an ambient temperature range varying between approximately -60° centigrade to approximately 200° centigrade.

34. The method of Claim 23, comprising generating millivolts of electrical voltage.